



**Armed Forces College of  
Medicine**  
**AFCM**



# Respiratory System

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## INTENDED LEARNING OBJECTIVES (ILO)



*By the end of this lecture, you should be able to:*

- List the components of the **conducting & respiratory portions** of the respiratory system.
- Describe the structure and correlated functions of the **olfactory mucosa**
- Describe the structure and correlated functions of the **respiratory mucosa**.
- Correlate the defective microscopic structure of **respiratory epithelium** as a **result of smoking**.
- Compare between layers of the wall of the **trachea and bronchi**.



- 1. Part 1 (5 min) Introduction**
- 2. Part 2 (35 min) Main lecture: Key points:**

- Nasal cavity.
- Olfactory epithelium.
- Structure of the trachea.
- Respiratory epithelium.
- Structure of intrapulmonary bronchi.

- 3. Part 3 (5 min) Summary**

# Components of Respiratory System



## CONDUCTING PART

**Nose**

**Nasopharynx**

**Larynx**

**Trachea**

**Bronchi**

**Bronchioles**  
Pre-terminal &  
(Terminal)

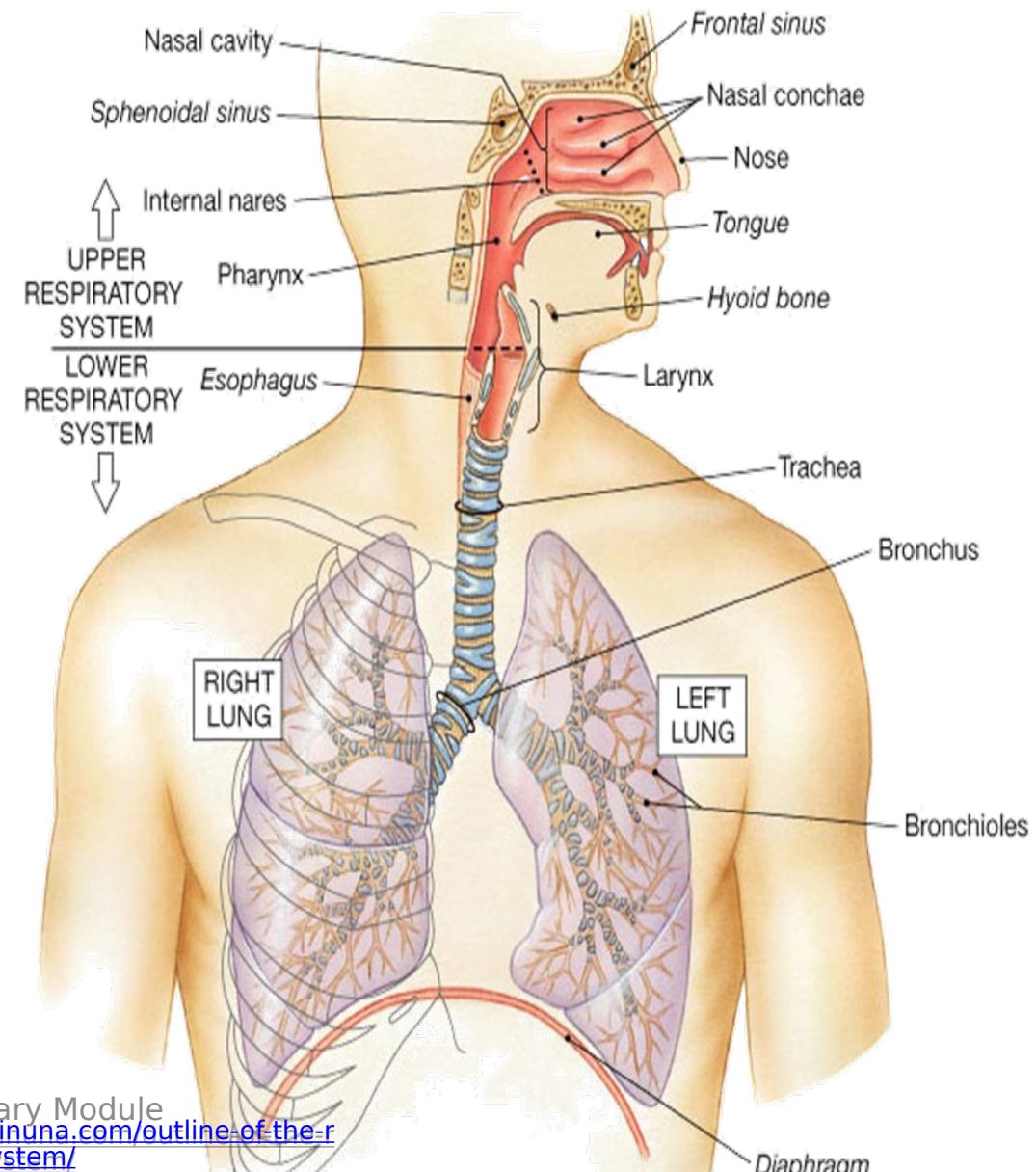
## RESPIRATORY PART

**Respiratory  
Bronchiole**

**Alveolar  
duct**

**Alveolar Sac**

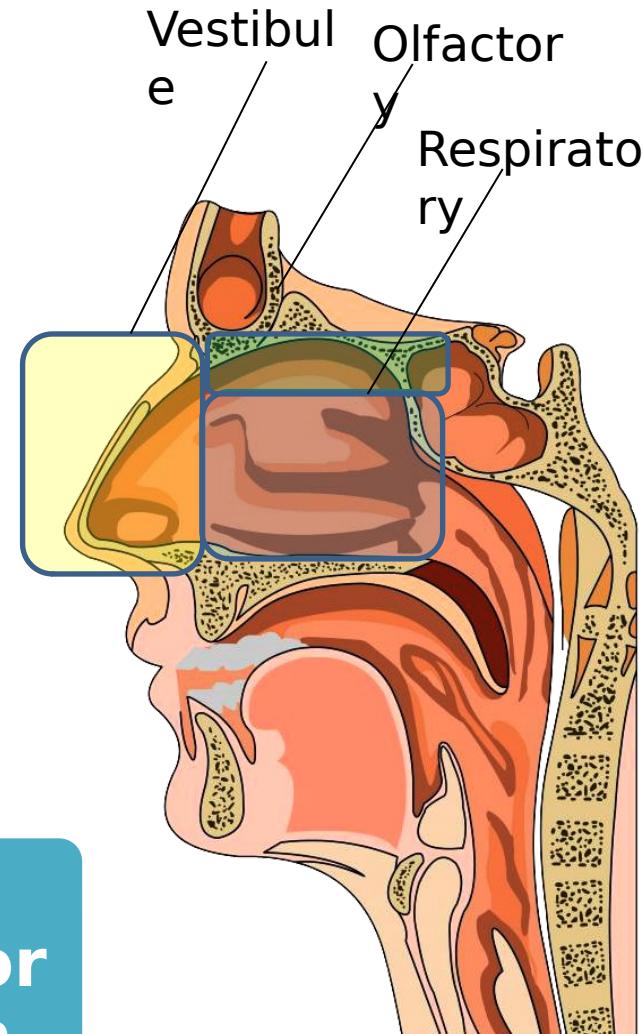
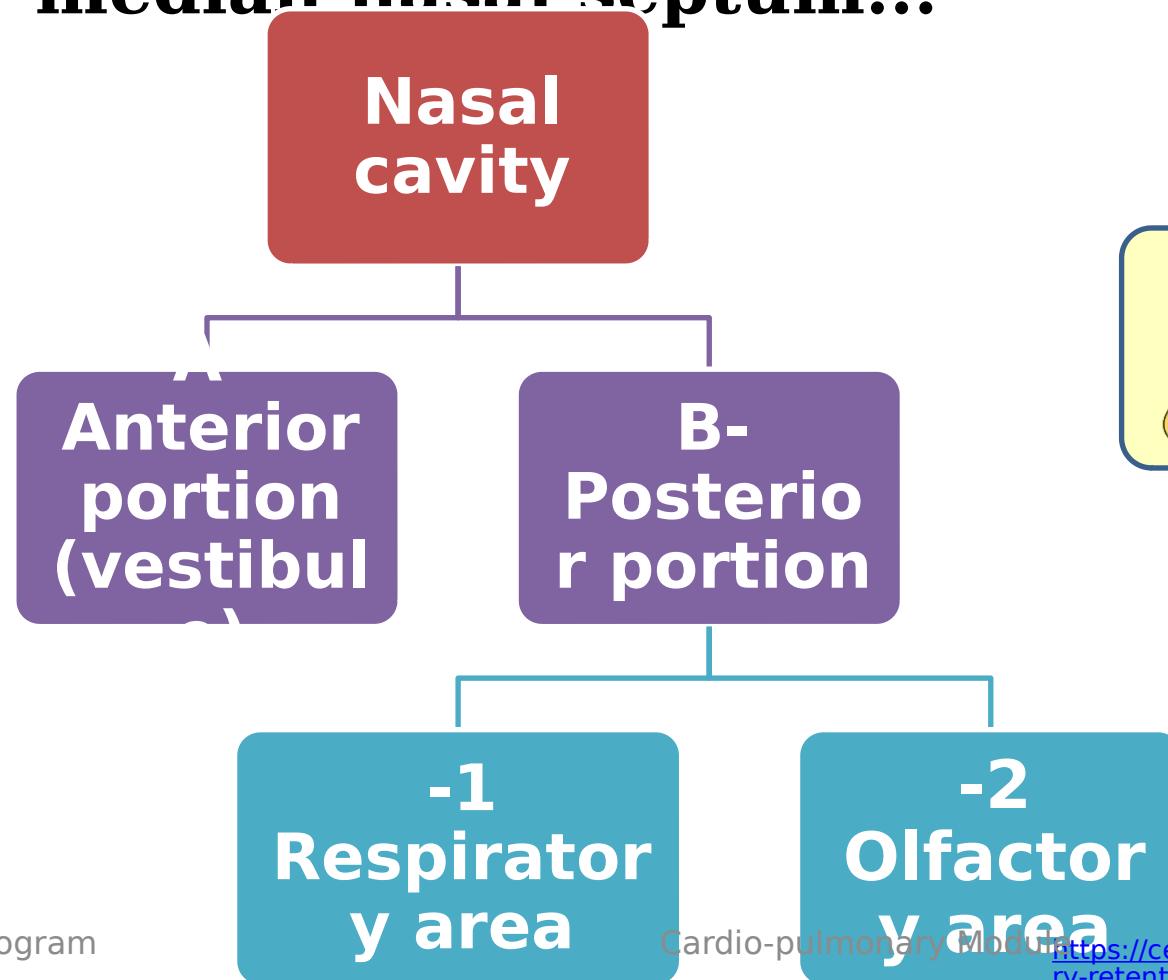
**Alveoli**



# 1- Nose



- It is divided into right and left nasal cavities by a median nasal septum...





## A- The anterior part of nasal cavity (the Vestibule)

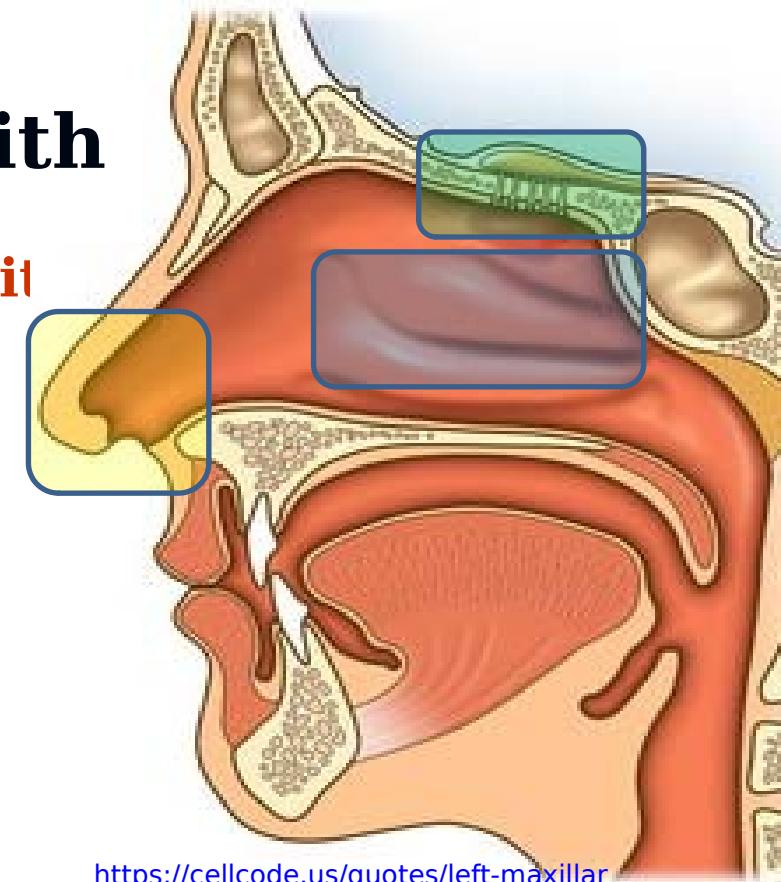
**It is lined with skin (epidermis & dermis) with short stiff hairs**

**B- The posterior part of nasal cavity**

**It is divided into two areas:**

**1-Olfactory area:**  
presents in the roof of the nasal cavity

**2-Respiratory area:**  
includes all the nasal



<https://cellcode.us/quotes/left-maxillary-retention-cyst.html>

# 1- Nose



## 1- The respiratory area

It is lined by mucous membrane

### 2-Lamina propria:

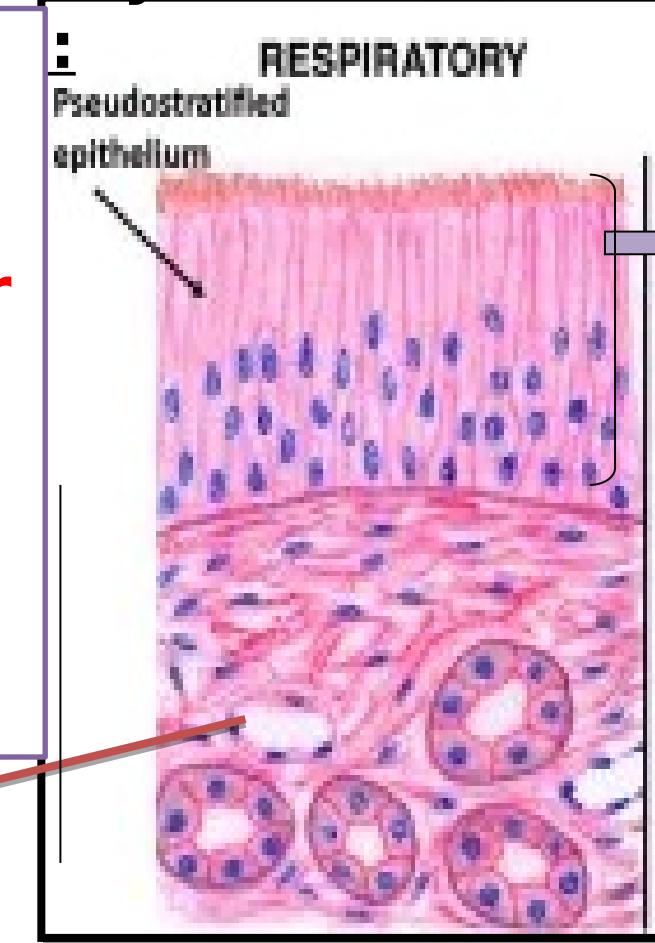
**dense fibroelastic C.T.**

- **Highly vascular**

- Contain **seromucous glands** → watery secretion

→ humidify  
inspire air  
The high  
vascularity

is for  
warming of  
the  
inspired air

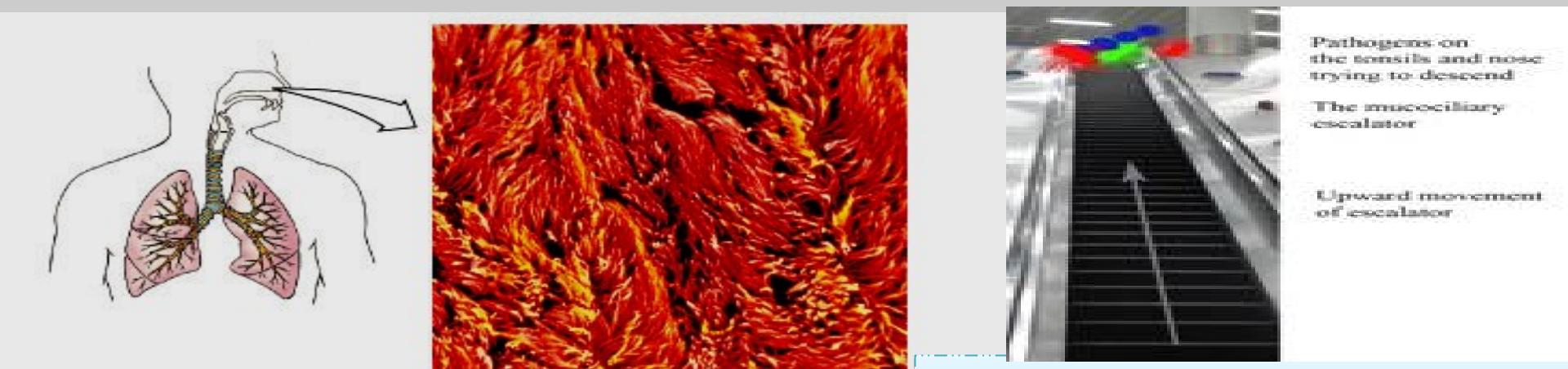


### 1- Respiratory epithelium:

**- Pseudo-stratified columnar ciliated epithelium with goblet cells**

**(=Respiratory epithelium).**

# 1- Nose

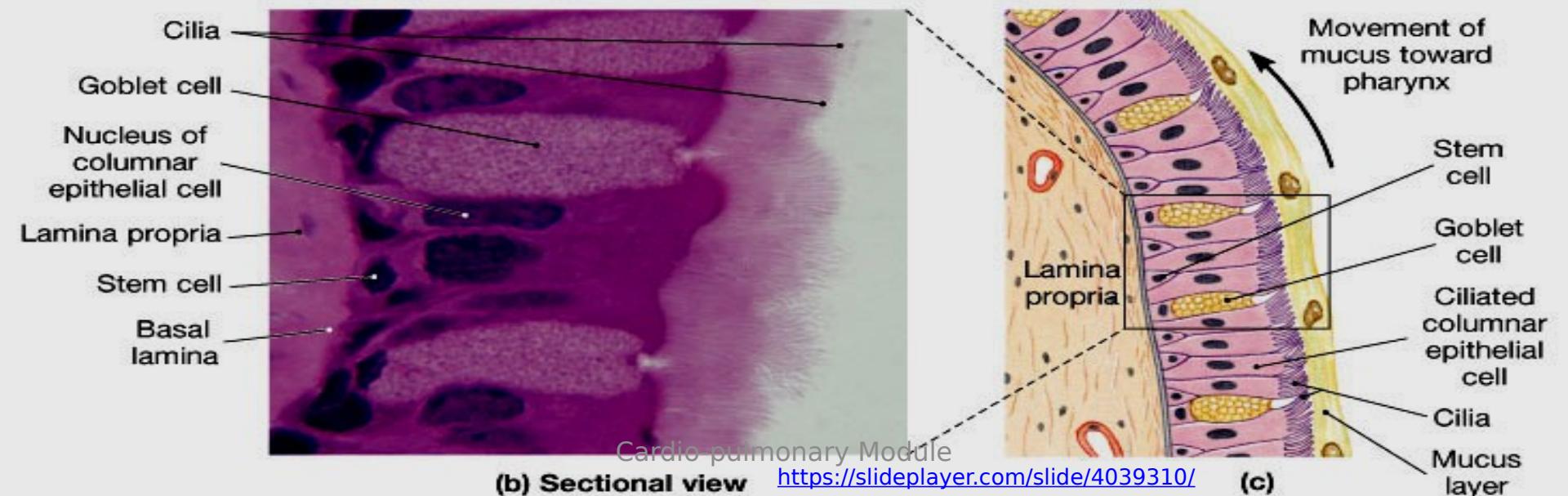


Pathogens on the tonsils and nose trying to descend

The mucociliary escalator

Upward movement of escalator

## Mucociliary escalator

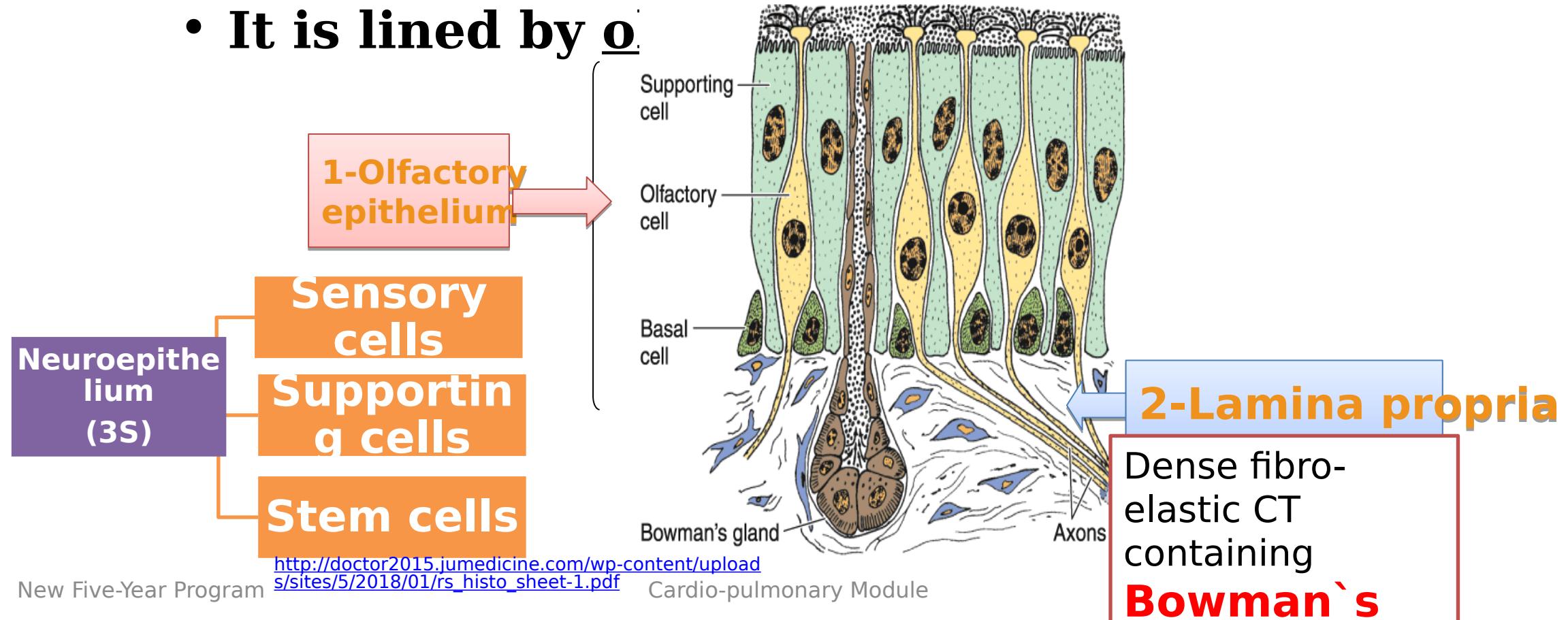


# 1- Nose



## 2- The olfactory area

- Site: It is present in the roof of the nasal cavity
- It is lined by o

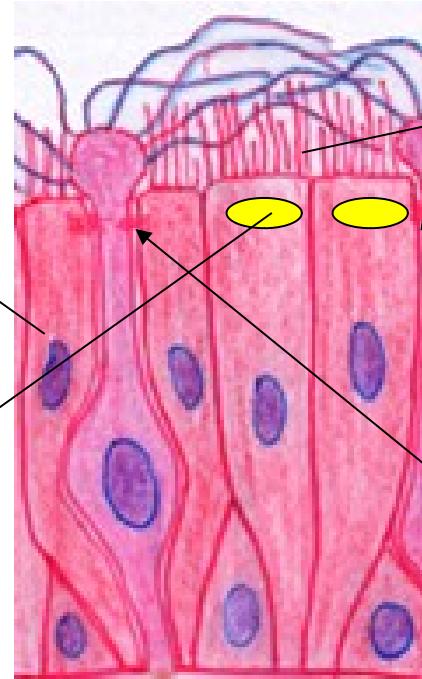




## Olfactory epithelium (Neuroepithelium)

### 1-Sustentacular ( supporting cells)

- Tall columnar cells with oval **apical nuclei**



- Apical microvilli trapping thin serous fluid.

•The apical **cytoplasm** has few pigment granules responsible for **yellow color** of olfactory epithelium

<http://www.anatomyqa.com/histology/respiratory-system/>

**Junctional complex**

**Function**  
Support, Insulation of the olfactory cells and Nutrition

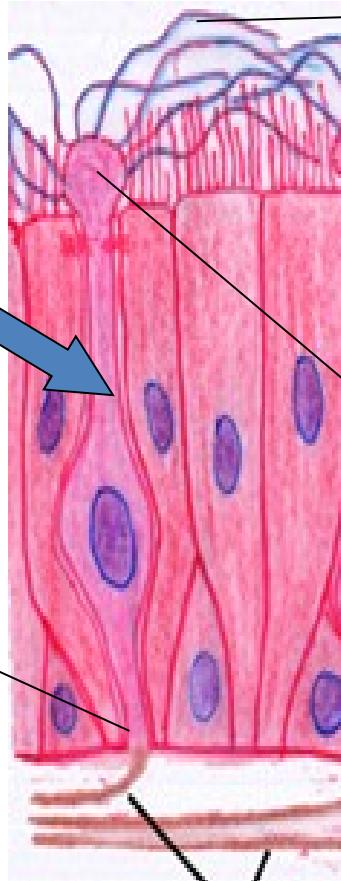


## The olfactory epithelium

### 2-Olfactory (chemoreceptor) cells:

They are **bipolar neuron**.

Their **unmyelinated axons** → lamina propria → olfactory nerve → CNS



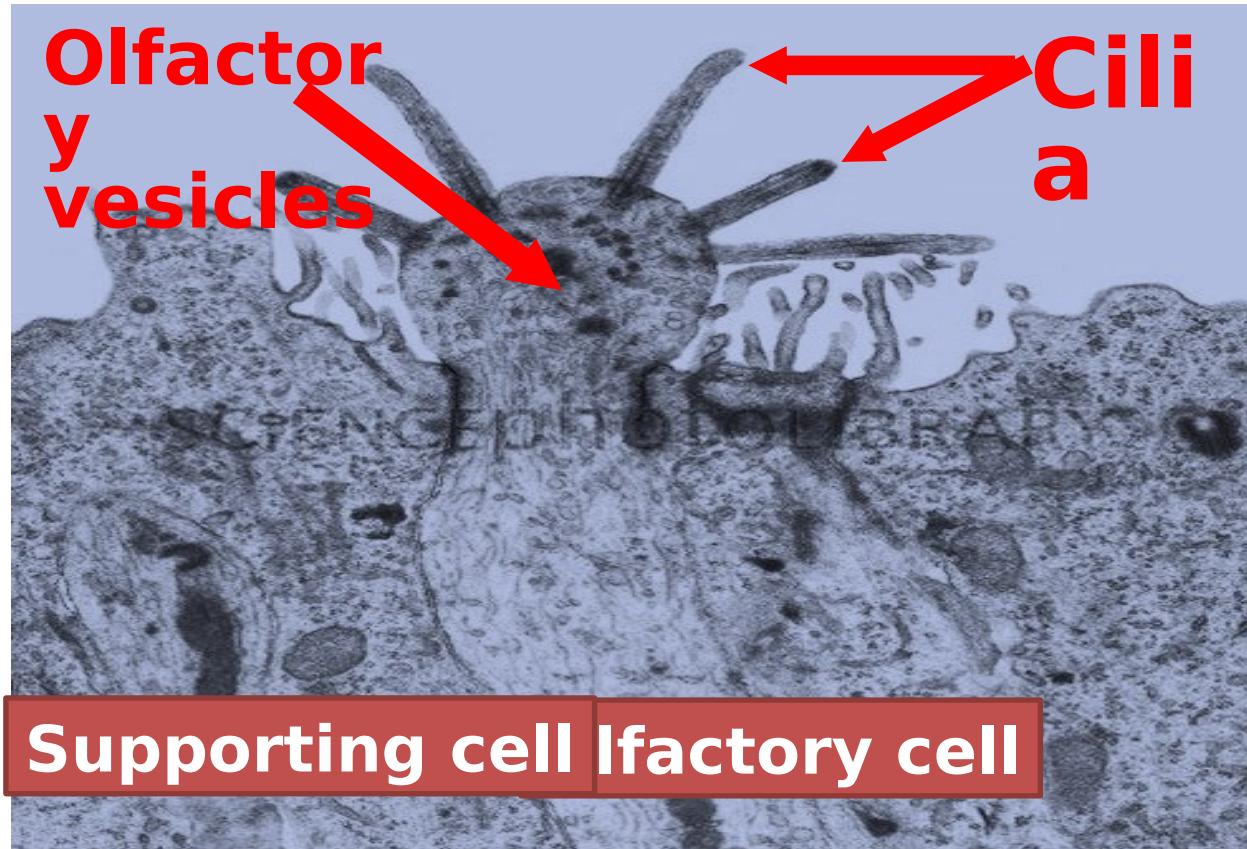
**Cilia** are long, non motile and lie flat on the epithelial surface.

Their **dendrites** are modified forming a **bulb (Olfactory vesicle)** arising from it 6-8 cilia. **It** contains the basal bodies of the cilia, mitochondria and rER.



## The olfactory epithelium

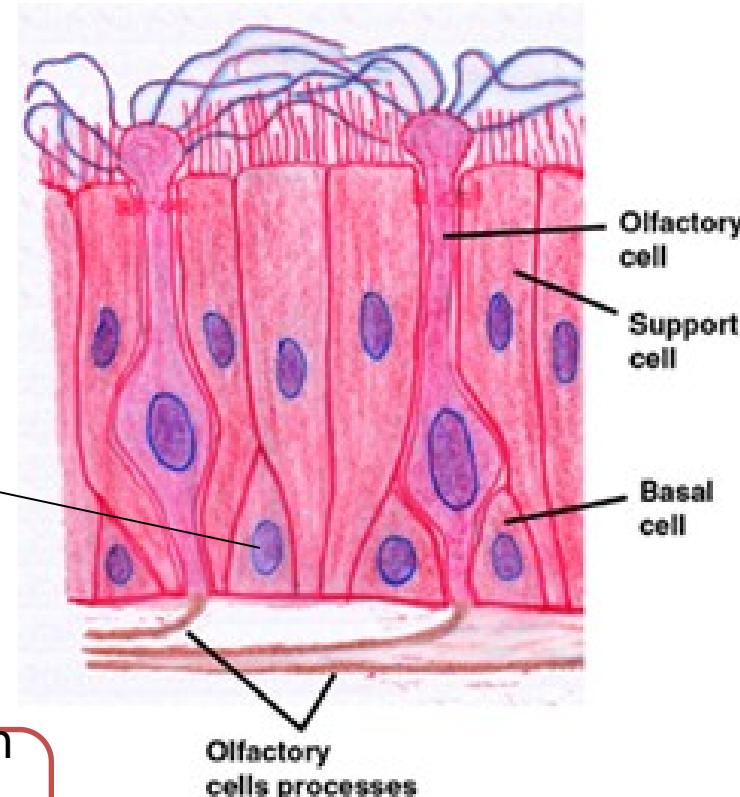
### 2-Olfactory (chemoreceptor) cells:





## The olfactory epithelium

### The basal cells (reserve or stem cells)-3



**They are small cells not reaching the surface**

These cells have been used in clinical trials for adult stem cells treatment

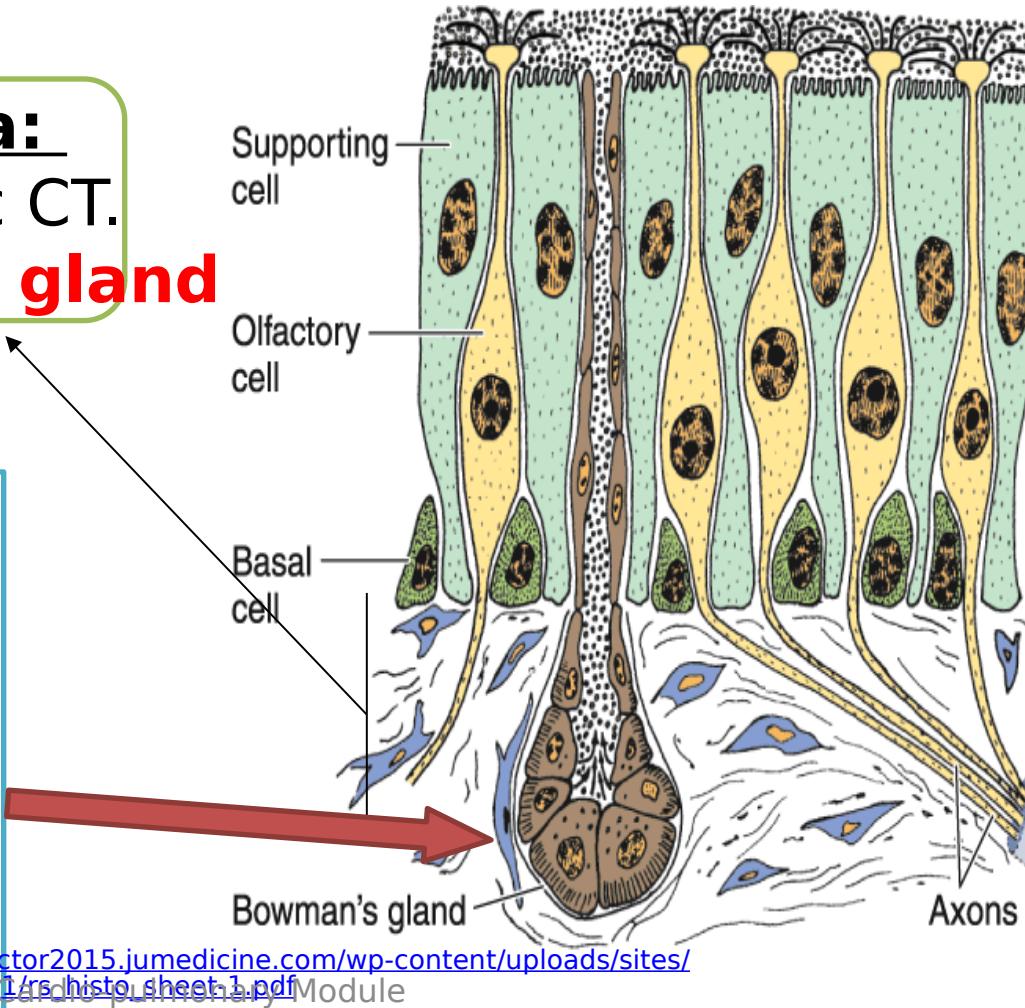
**Function:**  
They can divide & regenerate olfactory neurons every 2-3 months.



## Lamina propria of the olfactory area:

**Lamina propria:**  
dense fibro-elastic CT.  
Contains **Bowman's gland**

It produces watery (**serous**) secretion:  
**1.** Solvent for odorous gases  
**2.** Clear the epithelium for new stimulus.





# Medical Application



## Anosmia / Hyposmia

- Loss or reduction of the ability to smell can be caused by common cold or temporary????



**Due to regenerative activity of the olfactory basal stem cells**

# Paranasal sinuses



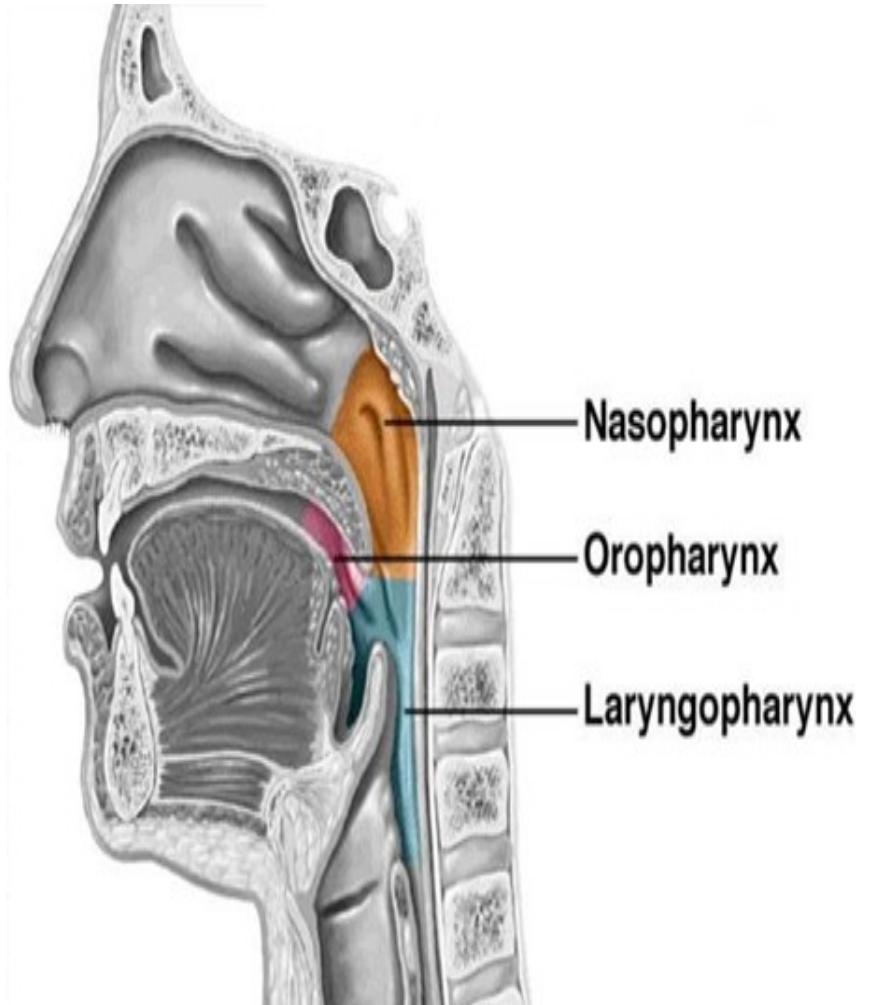
- Are bilateral cavities in the frontal, maxillary, ethmoid, and sphenoid bones of the skull.
- They are lined with respiratory epithelium.
- The paranasal sinuses communicate with the nasal cavities through small openings; mucus produced moves into the nasal passages by the activity of the ciliated cells.



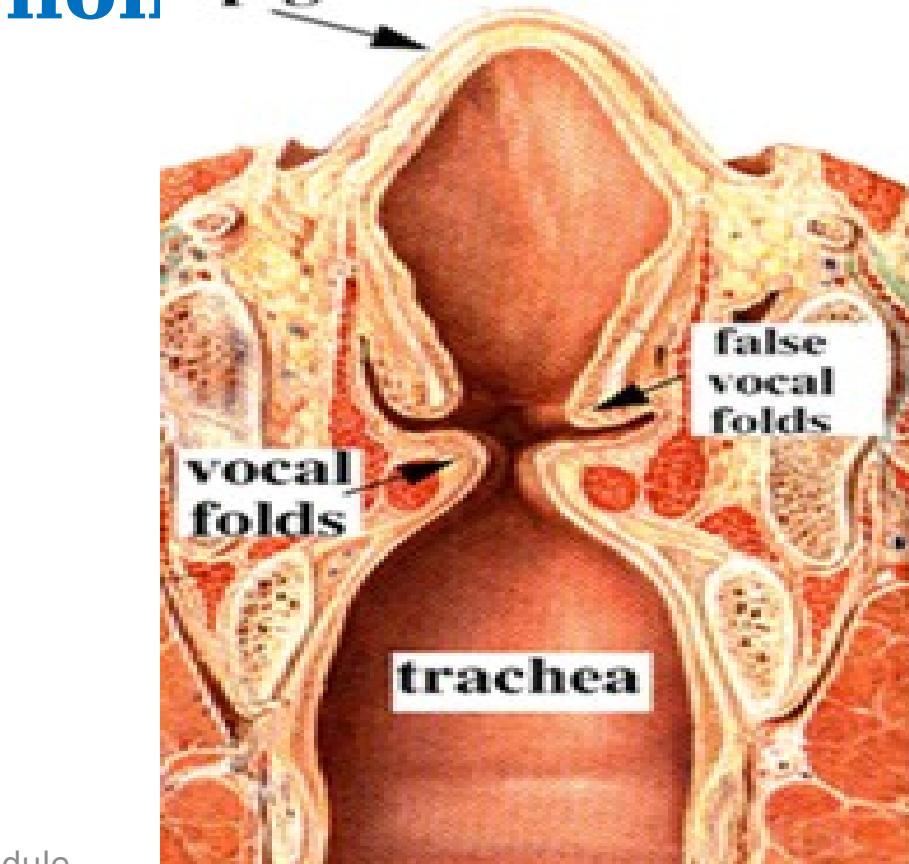
□ ***Sinusitis*** is an inflammatory process of the sinuses, mainly because of obstruction of drainage orifices.

# **2- Nasopharynx Larynx**

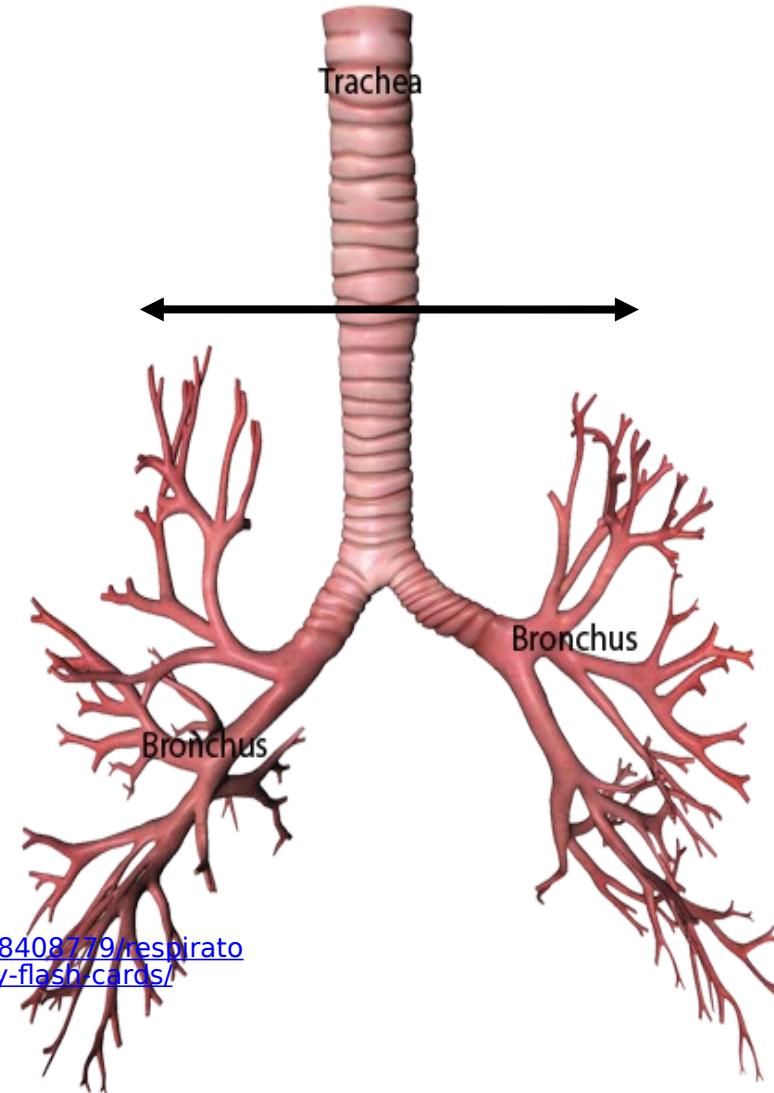
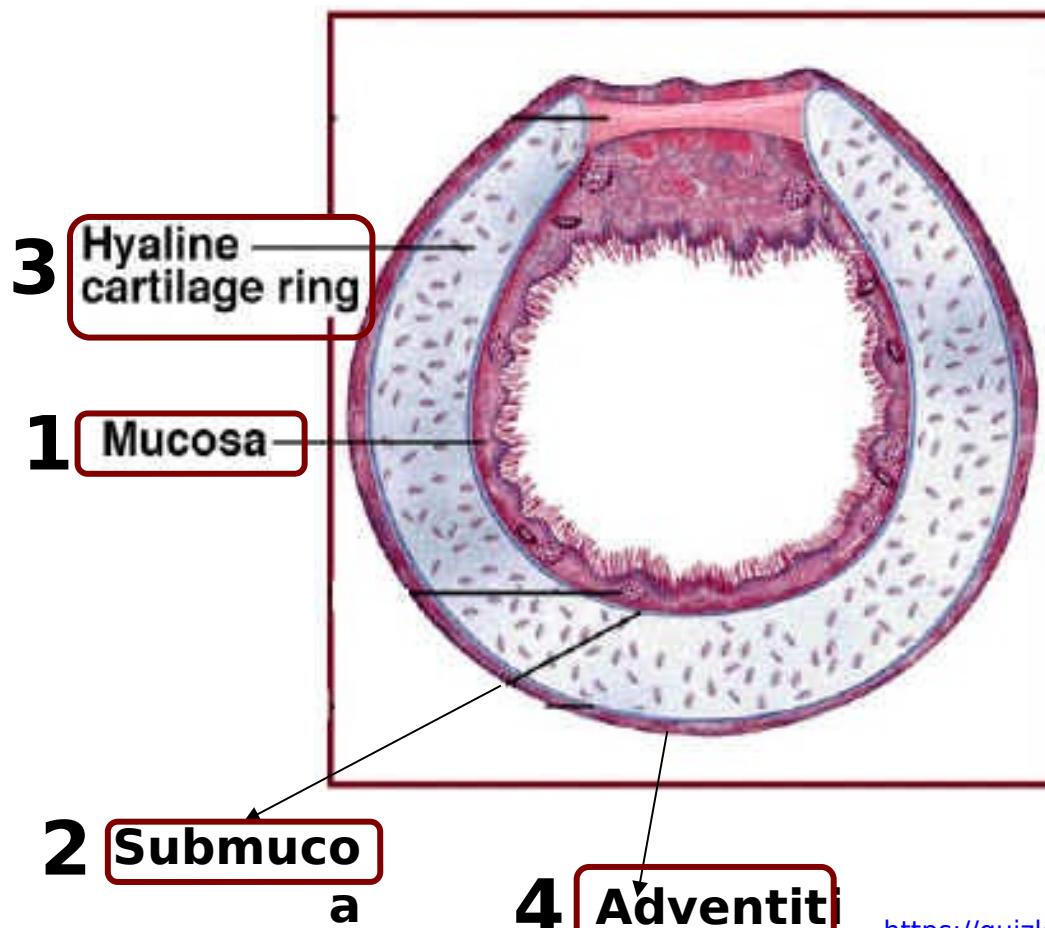
# Lined by **respiratory** epithelium



**Lined by Respiratory  
epithelium**  
except **vocal cords** → lined by  
**st. sq. ep.**  
**non epiglottis**



# 4- Trachea

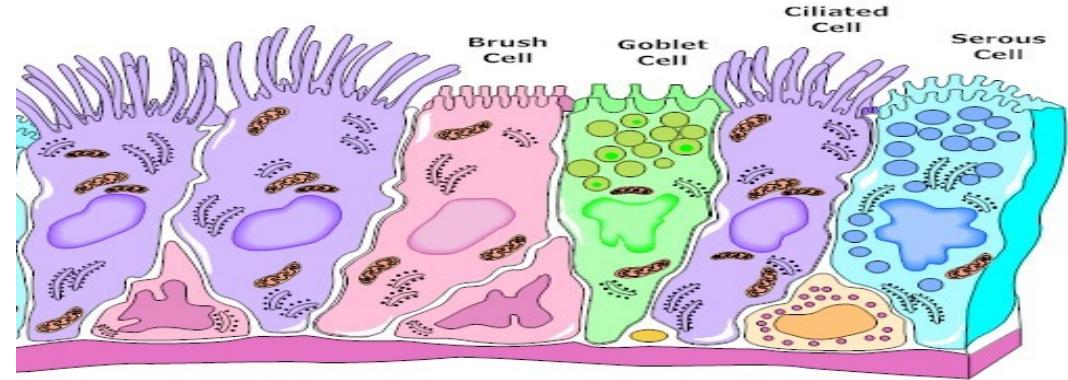
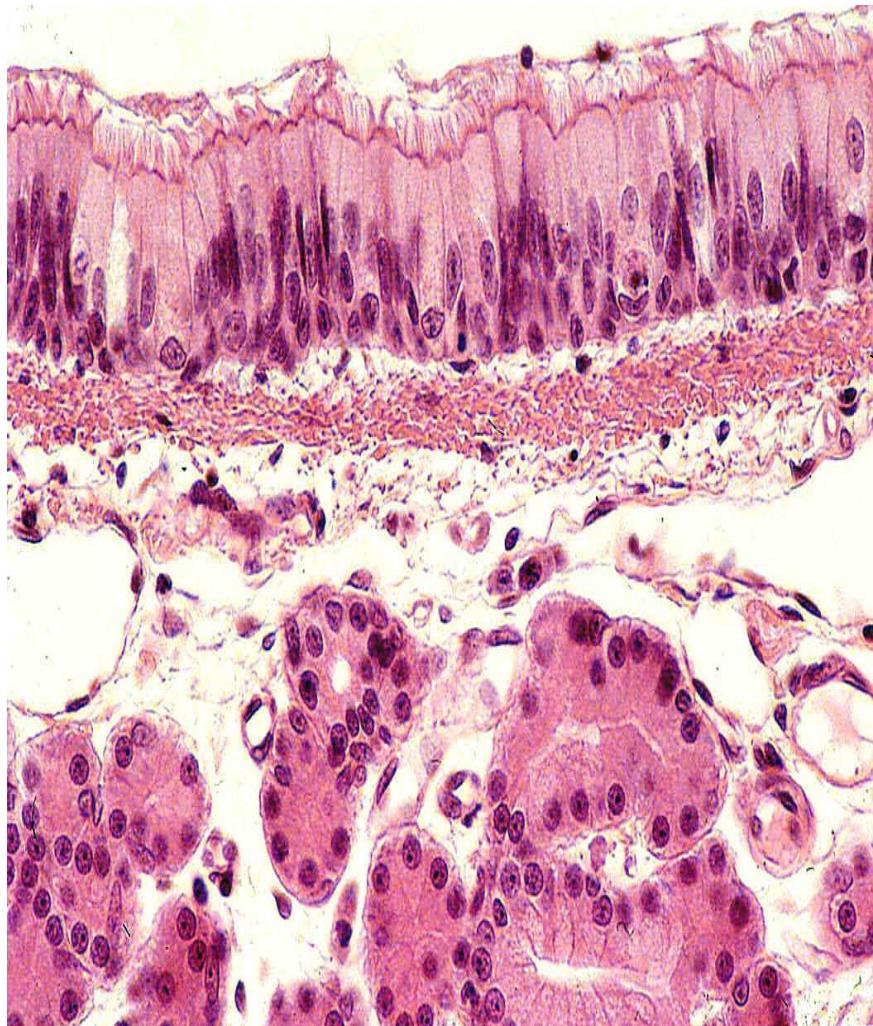


<https://quizlet.com/68408779/respiratory-flash-cards/>

The open ends of the cartilage rings are on the posterior surface, against the esophagus, and are bridged by a bundle of smooth muscle called the **trachealis muscle**.



## Mucosa of the trachea-1



<https://www.slideserve.com/abiola/respiratory-system-101>

**A) Respiratory epithelium  
(5 types of cells)**

**B) Lamina propria:  
CT rich in lymphocytes**

**It contains elastic membrane separating the mucosa from submucosa. It is responsible for elastic recoil of the trachea after expiration**

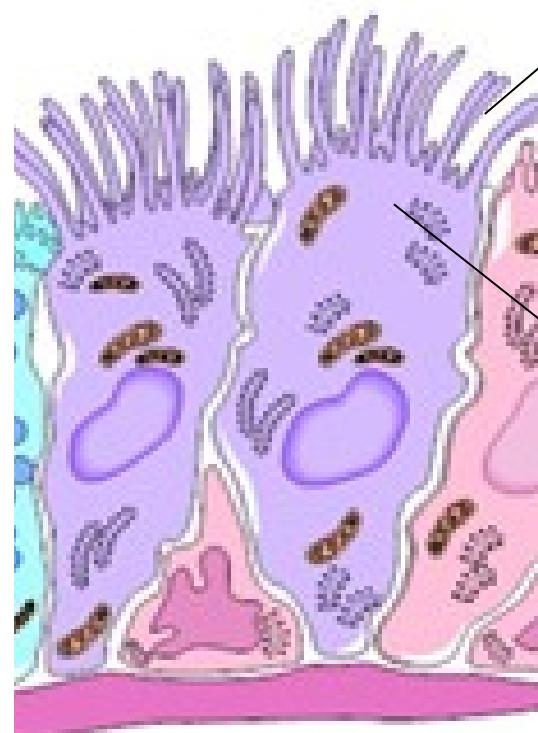
## 4- Trachea



**Respiratory epithelium (5 types of cells):  
pseudo-stratified columnar ciliated with  
goblet cells**

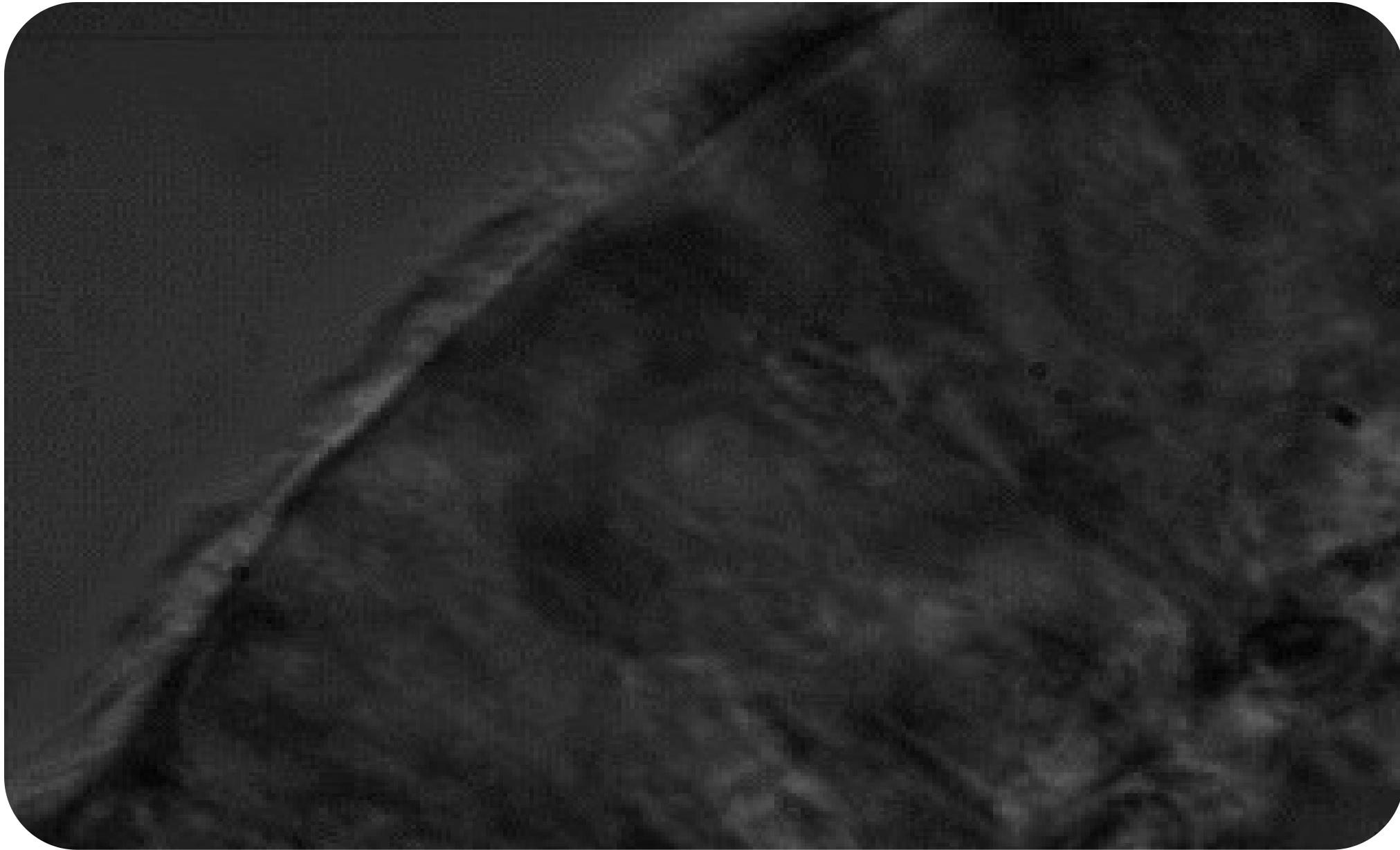
### **1-Ciliated columnar cell (30%):**

It is tall columnar cell with basal oval nucleus.



• Its apical surface is provided with **200-300 cilia** (beat toward the larynx).

The apical cytoplasm contains basal bodies of cilia and many mitochondria



<https://www.ciliopathyalliance.org/cilia>

## 4- Trachea

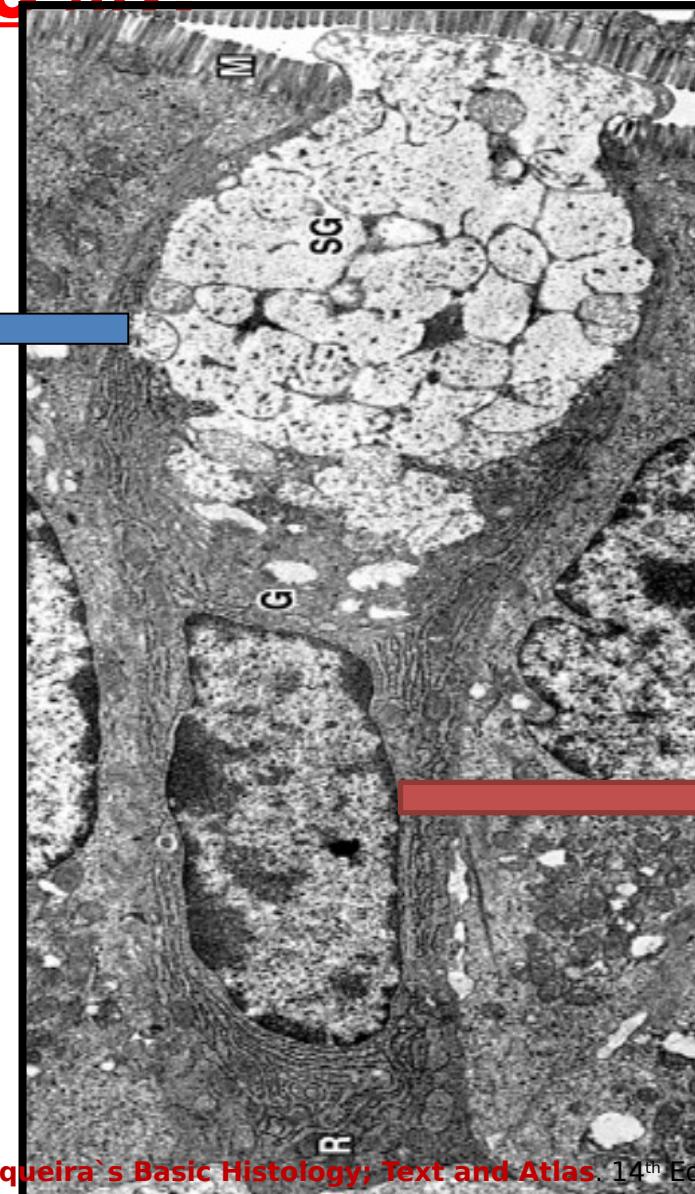


### 2-Goblet cell (30%)

**It has expanded apical part filled with mucinogen granules**

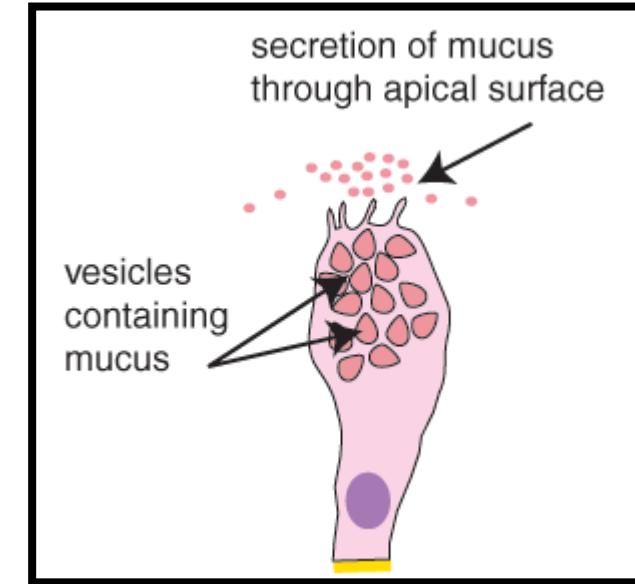


**In cystic fibrosis, the secreted mucus is thick or viscous and the cilia have a difficult time moving it toward the pharynx. Patients with this disease have frequent infections of the**



*Junqueira's Basic Histology; Text and Atlas. 14<sup>th</sup> Edition (2016)*

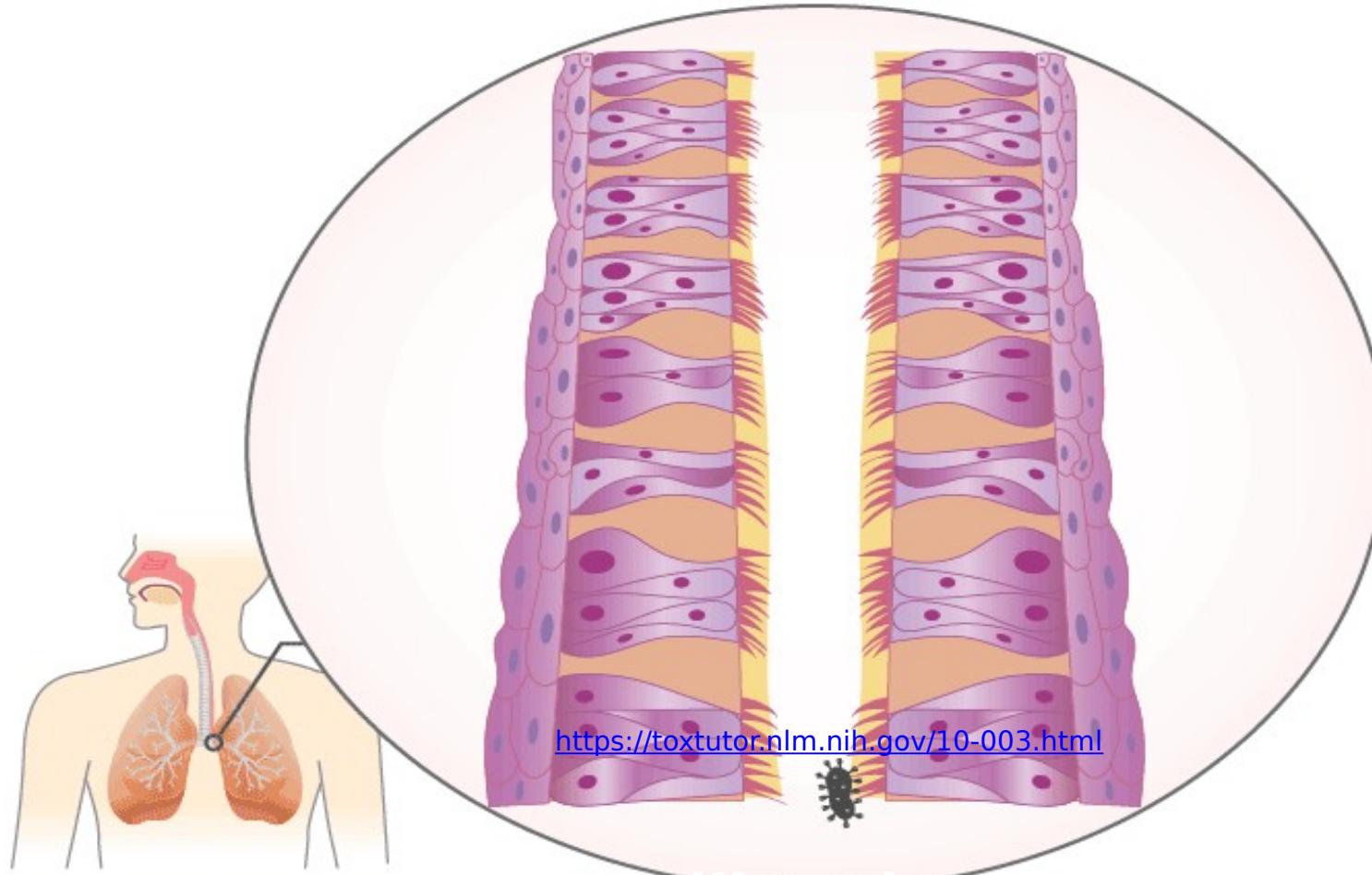
[https://www.histology.leeds.ac.uk/tissue\\_types/epithelia/epi\\_goblet\\_cell.php](https://www.histology.leeds.ac.uk/tissue_types/epithelia/epi_goblet_cell.php)



**The narrow basal part of the cell contains the nucleus, rER, Golgi complex and it is called**

Cardio-pulmonary Module

# 4- Trachea



**Goblet cells- ciliated cells= mucociliary  
escalator**

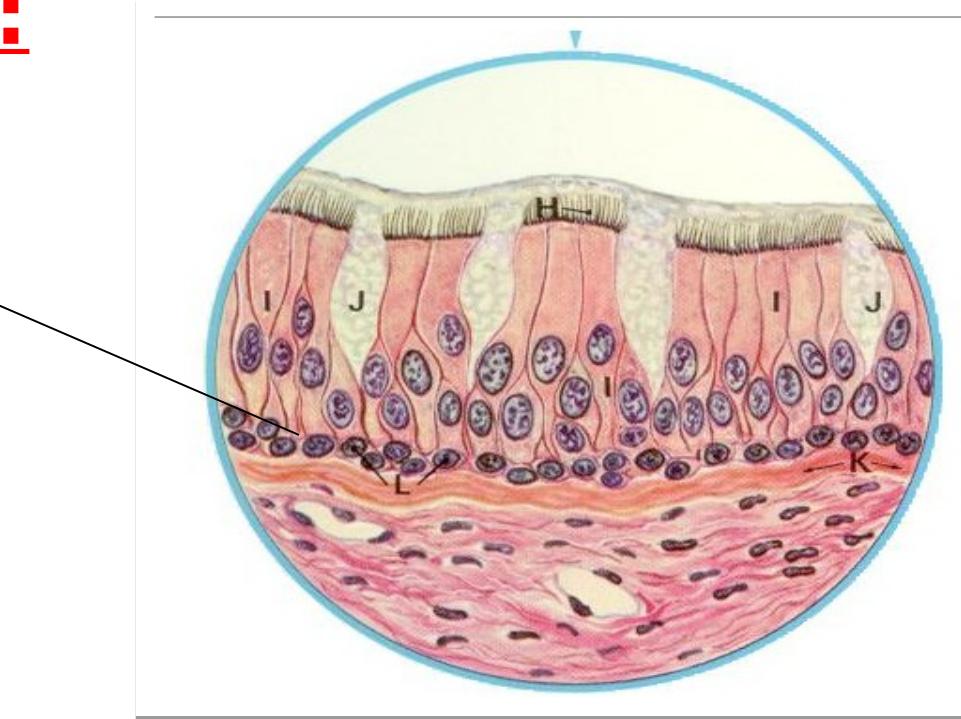
## 4- Trachea



### 3-Basal stem cell (30%):

- They are small rounded cells located on the basal lamina and not reaching the surface.

- They have **free**



[https://link.springer.com/chapter/10.1007/978-3-211-99390-3\\_104](https://link.springer.com/chapter/10.1007/978-3-211-99390-3_104)

**They can differentiate into ciliated and goblet cells**

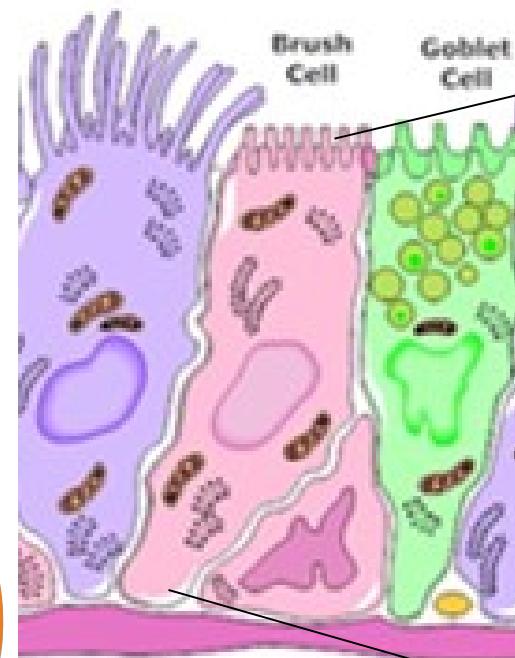
## 4- Trachea



### **4-Brush cell (3%):**

•They may act as:  
Sensory chemorecept

Brush cells may represent goblet cells that have secreted their products or intermediate stages in the formation of goblet or the tall ciliated cells.

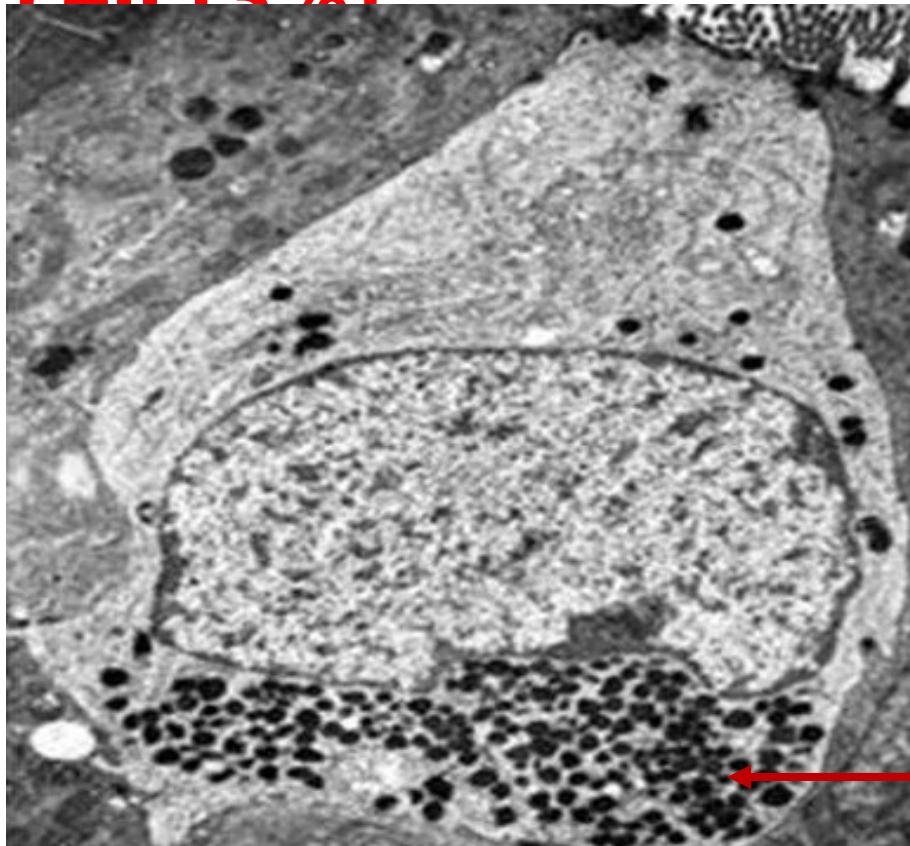


•**Columnar cell with short microvilli.**

•**There are **nerve endings** on their basal surface**



### 5- Neuroendocrine cells (DNES), Kulchitsky cell or K cell (3%)

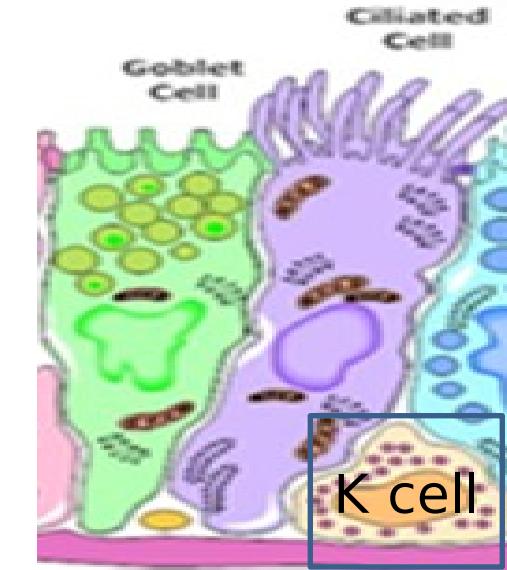


[o.com/flashcards/256740/GI+B+Anatomy/](http://o.com/flashcards/256740/GI+B+Anatomy/)



#### Clinical Correlate

Bronchial metastatic tumors (small cell carcinoma) arise from Kulchitsky cells.



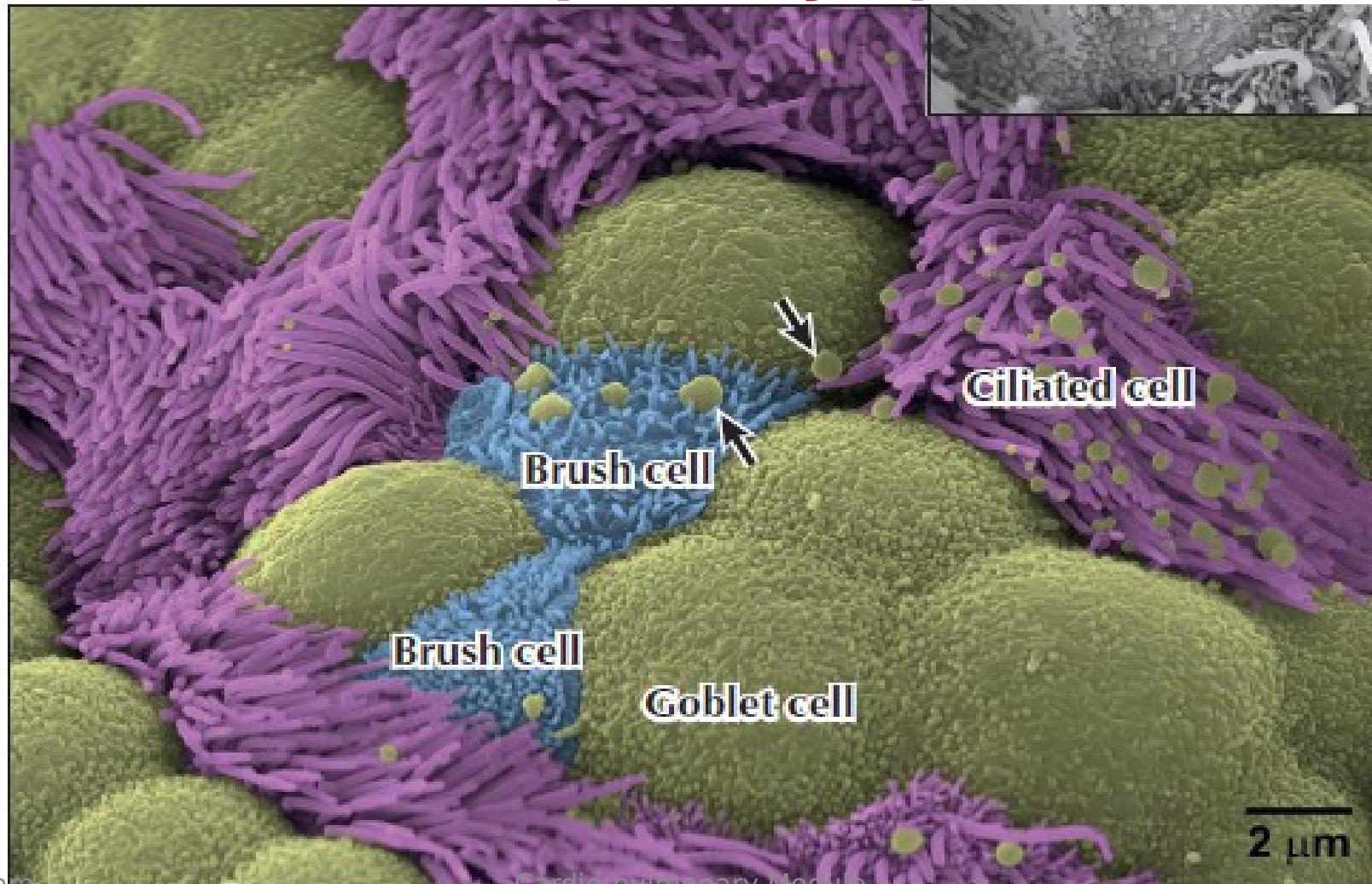
•Contain **basal electron dense secretory granules** to be released in blood vessels in I. P

•Function: They release **serotonin, bombesin.**

## 4- Trachea



### SEM of respiratory epithelium



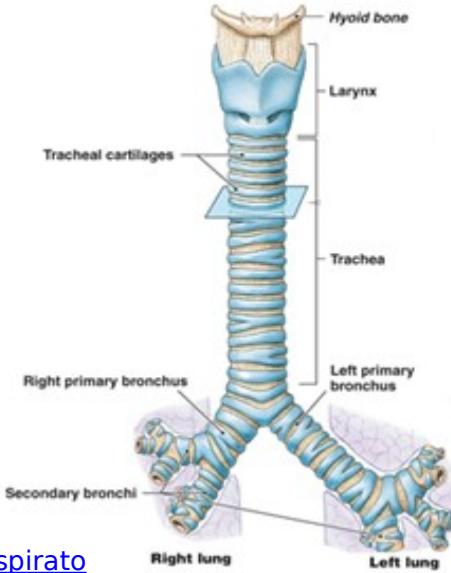
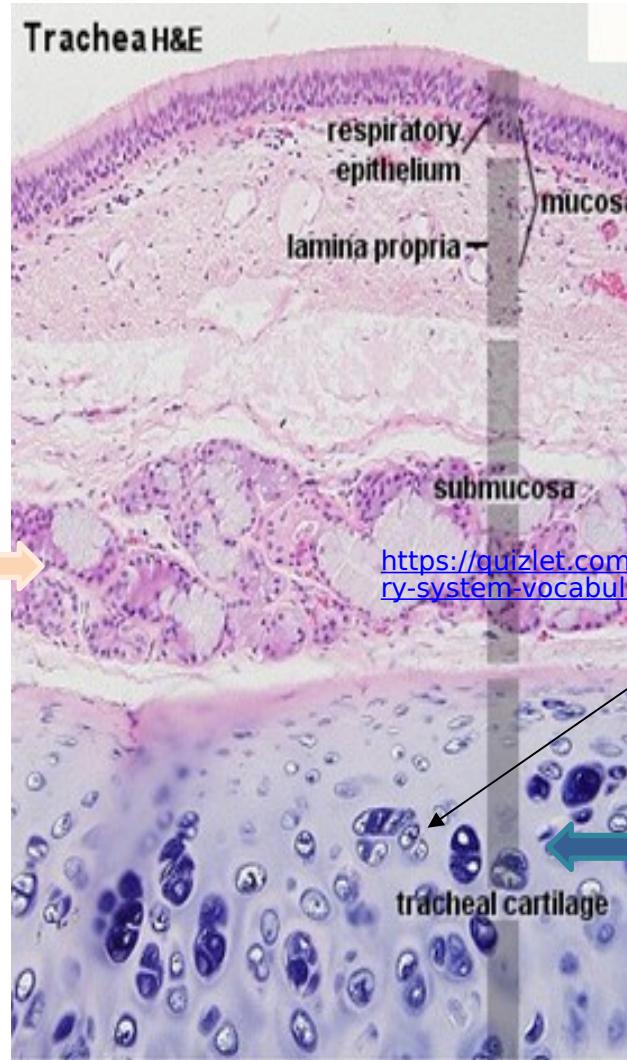
# 4- Trachea



## 2- submucosa: dense irregular fibroelastic CT.

- **It contains:**
  1. Lymphatic nodules.
  2. seromucous
  3. Blood vessels
  - 4- **Adventitia**

<https://hashe.com/mucous-connective-tissue-histology-5c148d628719620724ae2c04/>



**3- Fibrocartilage layer: 20 C-shaped hyaline cartilage**  
Posteriorly, the ends of the cartilage rings are spanned by a fibrous membrane containing smooth muscle fibers (**trachealis**)



# Medical Application

## ~~application~~



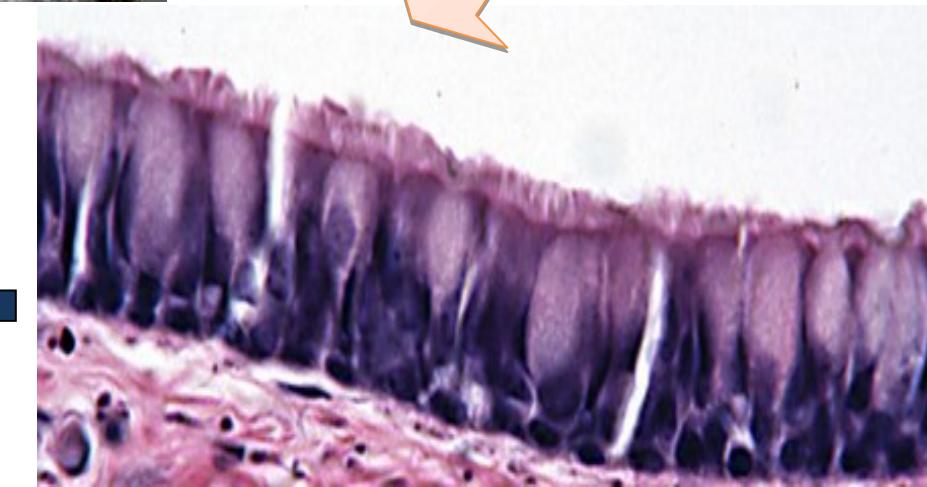
<https://www.gettyimages.com/photos/pseudostratified-epithelium>

**Normal respiratory epithelium**

↑ Goblet cells relative to ciliated cells

Goblet cells produce thicker mucus + ↓ number of ciliated cells

**SMOKING & coal**



↓ Rate of mucous removal

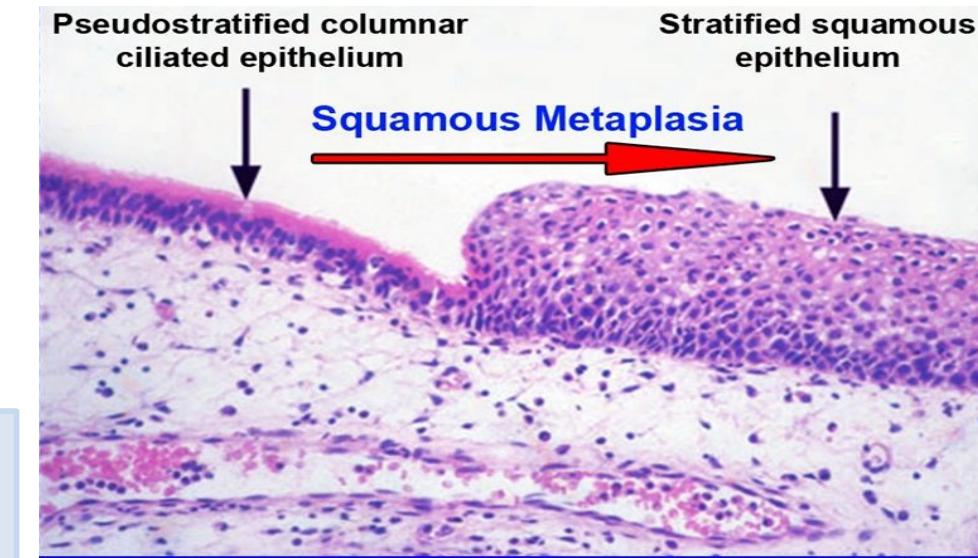
**Bacterial infection → chronic bronchitis**



## Respiratory metaplasia

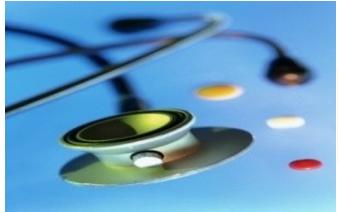
- The respiratory epithelium of people chronically exposed to irritants such as cigarette smoke and coal dust undergoes reversible changes known as metaplasia.

**Metaplasia : reversible replacement of one epithelial cell type with another one**



<https://slideplayer.com/slide/5258427/>

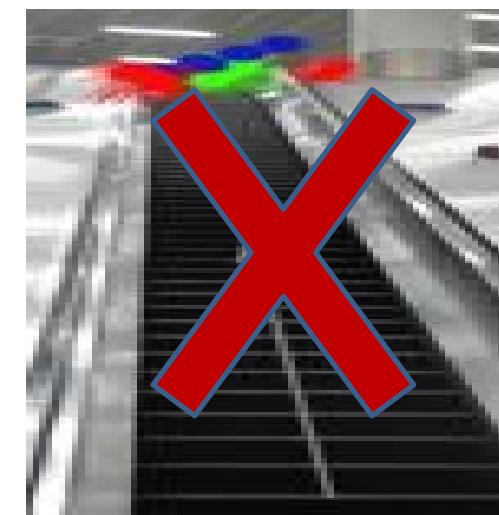
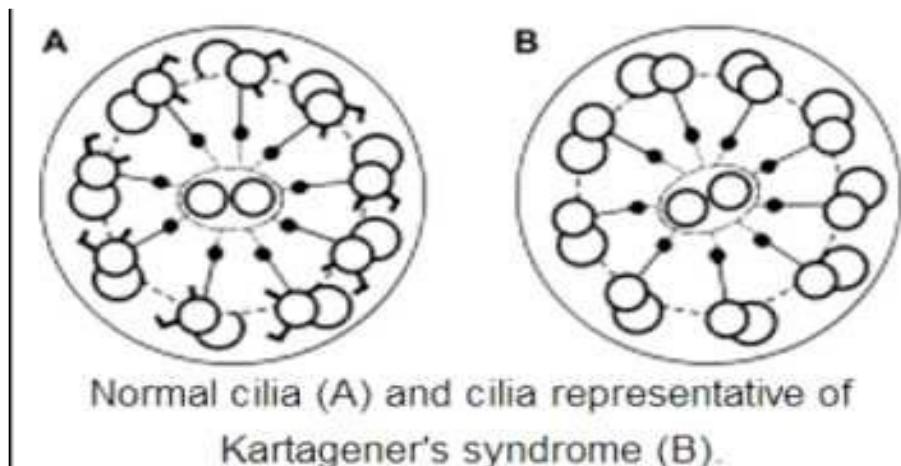
*Pseudostratified columnar ciliated* is transformed into→ ***stratified squamous epithelium***



Medical Application  
**Kartagener's syndrome**  
**(immotile cilia syndrome)**



- It is a genetic defect in dynein arm synthesis → cilia are immotile  
→ ↓ mucociliary clearance → chronic respiratory infections occur.



# 5- Bronchi

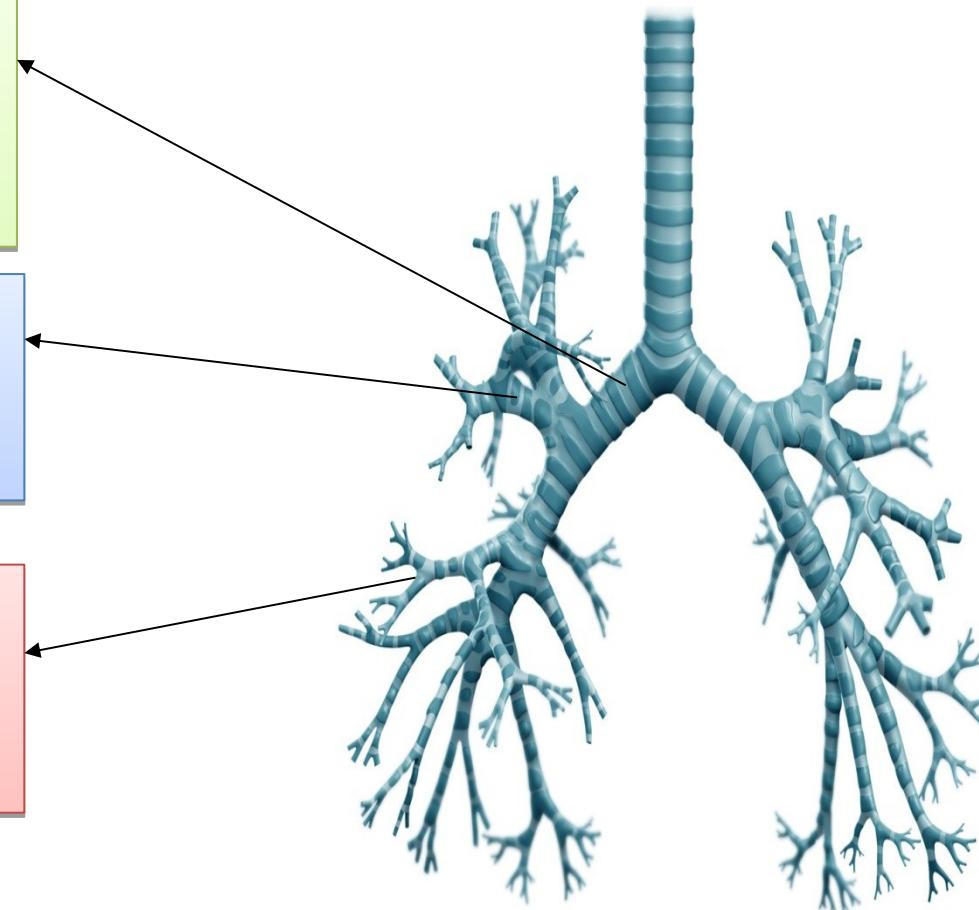


•**The bronchial tree consists of:**

**1-Primary bronchi  
(extrapulmonary) for each lung**

**2-Secondary bronchi  
(intrapulmonary) for each lobe**

**3-Tertiary bronchi for each pulmonary segment**



# 5- Bronchi

Structure of extra-pulmonary bronchi (1ry) is similar to trachea.

Structure of intra-pulmonary bronchi (2ry & 3ry).

### 3. Adventitia:

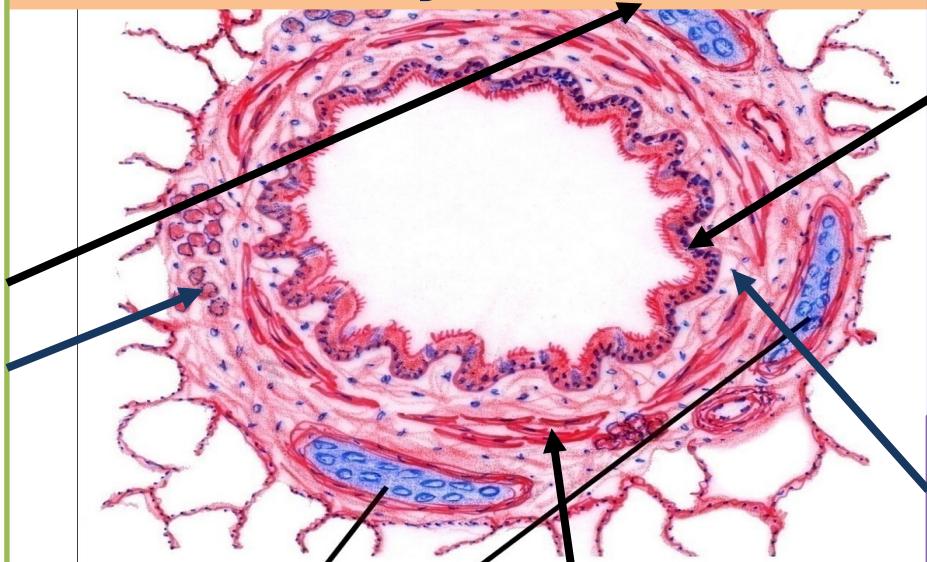
dense CT rich in elastic fibers contains:

- **Hyaline cartilaginous plates.**

- **Seromucous glands**

- **Lymphatic nodules**

(BALT=bronchial associated lymphatic tissue).



**Musculosa:** Well developed, spirally arranged smooth muscle fibers.

### 1. Mucosa:

- **Epithelium:** pseudo-stratified columnar ciliated epithelium with goblet cells

- **Lamina propria:** CT rich in elastic fibers and contains **solitary lymphoid nodules**.

# Lecture Quiz



- ***The vestibule of the nasal cavity is lined by:***
- a. Respiratory epithelium**
- b. Olfactory epithelium**
- c. Stratified columnar epithelium**
- d. Stratified squamous keratinized epithelium**
- e. Stratified squamous non keratinized epithelium**



- ***The sustentacular cells of the olfactory epithelium:***
  - a. They are basal in position
  - b. They have apical secretory granules
  - c. They have apical motile cilia
  - d. They transmit nerve impulses to olfactory cells
  - e. They have dilated apical vesicle



- ***K cells in the respiratory epithelium is:***
- a. Surfactant secreting cell that lines alveoli.**
- b. Fibroblast in the interalveolar septum.**
- c. Neuroendocrine cell that lines trachea.**
- d. Clara cell that lines bronchioles.**
- e. Mucous secreting cell that lines trachea.**

# Summary



- **Respiratory system is divided into conducting portion and respiratory portion**
- **Nasal cavity is divided into anterior portion (vestibule) and posterior portion (respiratory and olfactory areas) and its lateral wall contains conchae.**
- **Olfactory epithelium composed of olfactory bipolar neurons, support cells and stem cells.**
- **The nasopharynx is lined with pseudostratified columnar ciliated epithelium**
- **The larynx is lined with respiratory epithelium except the vocal cords and anterior surface of epiglottis are lined by stratified squamous non keratinized epithelium.**
- **Trachea is formed of 4 layers: mucosa, submucosa, fibrocartilagenous layer and adventitia.**
- **Intrapulmonary bronchi are formed of 3 layers: mucosa, muscle layer and adventitia containing plates of hyaline cartilage,**

## SUGGESTED TEXTBOOKS



- **Mescher A (2021):** Junqueira's Basic Histology, Text and Atlas. 16th Edition. Lange medical books/Mc Graw-Hill.
- **Netter's Essential Histology.** 2<sup>nd</sup> Edition (2013).

THANK  
YOU

The image displays the words "THANK" and "YOU" in a 3D perspective. The word "THANK" is positioned above "YOU". Each word is composed of four blocks, with the letters "T", "H", "A", "N" in "THANK" and the letters "Y", "O", "U" in "YOU" respectively. The blocks are colored in a repeating pattern: purple, blue, red, and yellow. The blocks are set against a plain white background.